

**SPS-1 Construction Report
US-54 Near Greensburg, Kansas
Sections 200101 to 200164**

SHRP North Central Region

Report Prepared by:

**Ann M. Johnson, P.E.
Braun Intertec Corporation
1983 Sloan Place, Suite 10
St. Paul, MN 55117**

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SPS-1 Experimental Design and Research Plan

The SPS-1 experiment has been developed to study the structural factors for flexible pavements. The objective of the study is to more precisely determine the relative influence of factors on the performance of flexible pavements. Those factors include drainage, base type and thickness, and asphalt surface thickness. The study objective includes a determination of the influence of environmental region and soil type on these factors. Accomplishing these objectives will provide substantially improved tools for use in the design and construction of new and reconstructed flexible pavements.

Some of the products of this experiment will help accomplish the objectives of the SHRP LTPP program. The key products from the SPS-1 experiment will include an evaluation of the existing design methods, development of improved design equations for new and reconstructed pavements, determination of the effects of specific design features on pavement performance, and development of a comprehensive data base for use by state and provincial engineers and other researchers.

Development of the national pavement data base is the tool to produce the analyses needed to produce the other products. This data base will permit centralized and efficient distribution of massive quantities of data to participating highway authorities, researchers, and other interested people. The data produced by this experiment will be used to evaluate existing design methods and performance equations. The AASHTO basic design equation for flexible pavements can be evaluated by comparing observed serviceability index against that predicted by the design equation. All of the inputs concerning the pavement structure, traffic, environment, drainage and material properties will be quantified. This experiment will also permit the variability associated with each of the inputs to be quantified and allow evaluation of the reliability aspects of the mode.

The proposed experimental design is aimed directly at determining the effects of the following specific pavement design features:

1. In-pavement drainage systems
2. Base type
3. Base thickness
4. Pavement thickness

The interaction of these factors will be determined in combination with the effect of environmental region and soil type. The effects of these factors will be studied under realistic performance conditions with significant materials and construction control. This experiment will add significantly to the understanding of the long-term performance of flexible pavements with asphaltic concrete surfaces.

Table 1 gives the basic experiment design for the SPS-1 experiment. The SPS-1 experiment in Kansas includes those sections listed in the R cells, for fine-grained soils in the dry-freeze zone.

Experimental Design for SPS-1: Strategic Study of
Structural Factors for Flexible Pavements

PAVEMENT STRUCTURE COMBINATIONS			
DRAINAGE	BASE TYPE	TOTAL BASE THICK	SURFACE THICK
NO	AGG	8"	4"
			7"
		12"	4"
			7"
	ATB	8"	4"
			7"
		12"	4"
			7"
	ATB 4" AGG	8"	4"
			7"
		12"	4"
			7"
YES	PATB AGG	8"	4"
			7"
		12"	4"
			7"
		16"	4"
			7"
	ATB PATB	8"	4"
			7"
		12"	4"
			7"
		16"	4"
			7"

FACTORS FOR MOISTURE, TEMPERATURE, SUBGRADE TYPE, AND LOCATION															
WET								DRY							
FREEZE				NO FREEZE				FREEZE				NO FREEZE			
FINE	COARSE	FINE	COARSE	FINE	COARSE	FINE	COARSE	FINE	COARSE	FINE	COARSE	FINE	COARSE	FINE	COARSE
J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
	K1		M1		O1		Q1		S1		U1		W1		Y1
J1		L1		N1		P1		R1		T1		V1		X1	
J2		L2		N2		P2		R2		T2		V2		X2	
	K2		M2		O2		Q2		S2		U2		W2		Y2
J3		L3		N3		P3		R3		T3		V3		X3	
	K3		M3		O3		Q3		S3		U3		W3		Y3
	K4		M4		O4		Q4		S4		U4		W4		Y4
J4		L4		N4		P4		R4		T4		V4		X4	
J5		L5		N5		P5		R5		T5		V5		X5	
	K5		M5		O5		Q5		S5		U5		W5		Y5
	K6		M6		O6		Q6		S6		U6		W6		Y6
J6		L6		N6		P6		R6		T6		V6		X6	
J7		L7		N7		P7		R7		T7		V7		X7	
	K7		M7		O7		Q7		S7		U7		W7		Y7
	K8		M8		O8		Q8		S8		U8		W8		Y8
J8		L8		N8		P8		R8		T8		V8		X8	
	K9		M9		O9		Q9		S9		U9		W9		Y9
J9		L9		N9		P9		R9		T9		V9		X9	
	K10		M10		O10		Q10		S10		U10		W10		Y10
J10		L10		N10		P10		R10		T10		V10		X10	
J11		L11		N11		P11		R11		T11		V11		X11	
	K11		M11		O11		Q11		S11		U11		W11		Y11
J12		L12		N12		P12		R12		T12		V12		X12	
	K12		M12		O12		Q12		S12		U12		W12		Y12

AGG = Dense-graded untreated aggregate base

ATB = Dense-graded asphalt treated base

PATB = 4" thick open-graded permeable asphalt-treated drainage layer,
underneath ATB or over AGG base

4" AGG = 4" thick dense-graded untreated aggregate base layer underneath ATB

Table 1. Experimental Design for SPS-1

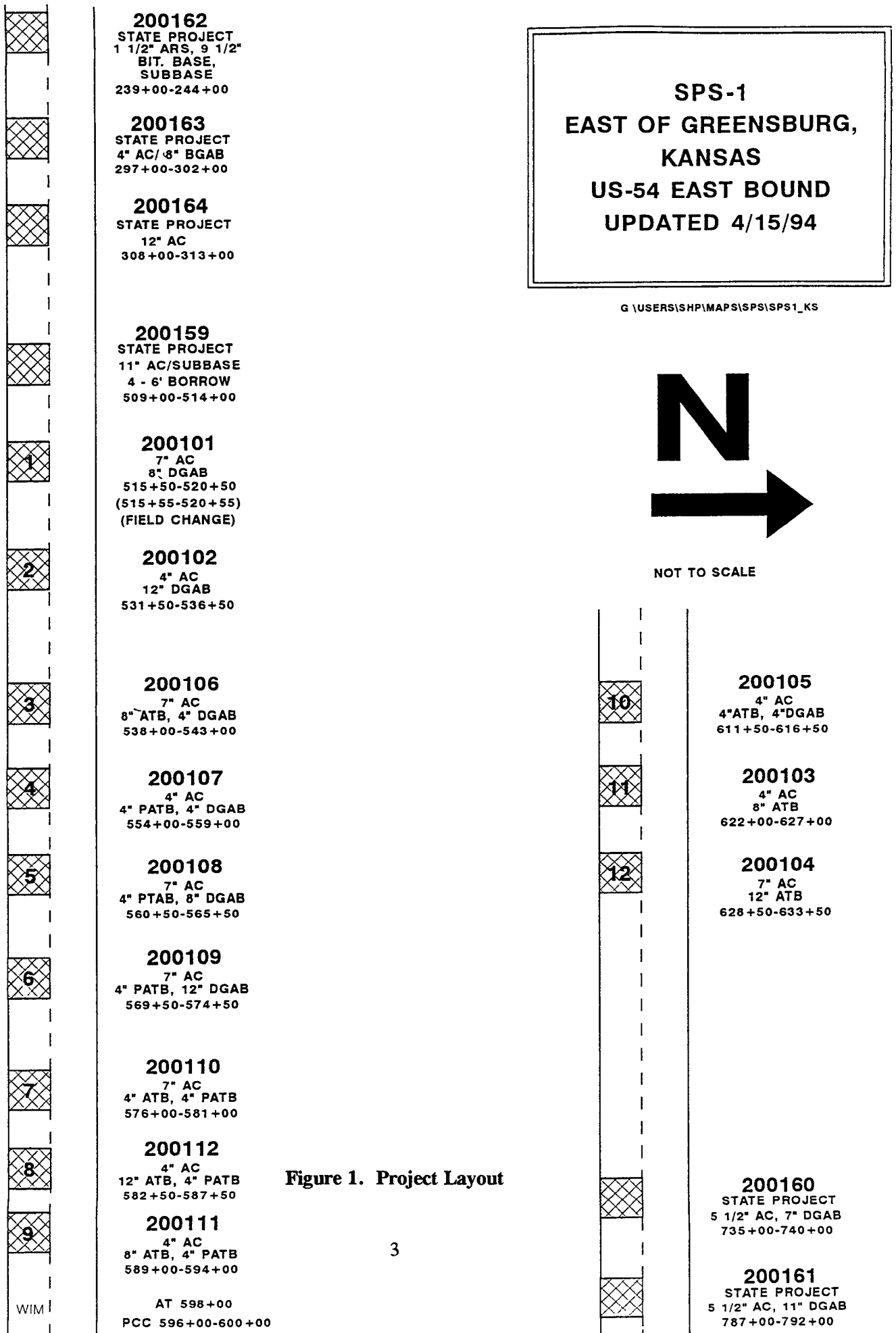


Figure 1. Project Layout

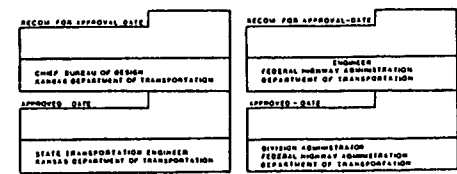
Project Details

The Kansas SPS-1 project was constructed in 1993 and is located in the eastbound driving lane of US-54, near Greensburg (see Figure 2 for project location). The project involved the new construction of a two-way asphalt-surfaced roadway, offset from the original alignment by approximately 50 feet. The SPS experiment consists of twelve standard SPS-1 test sections, plus one Kansas DOT control section and five supplemental sections, and is built in the dry-freeze zone. Subgrade soils on the project are sandy silt. An SPS-9 project was also constructed adjacent to the SPS-1, from station 205+00 to 273+00.

The typical sections for the project are shown in Figure 3. The Kansas DOT has calculated estimated service life of the SPS sections, which are shown below in Table 2. Existing topsoil was removed, the underlying materials subcut to accommodate the pavement thicknesses, and the base and surface layers placed in various thicknesses. Material was placed and compacted according to KDOT Standard Specifications Section 210.

Table 2. Estimated Life of Kansas SPS-1 Sections

Section Number	Estimated Life (yrs)
200162	10
200163	13
200164	20
200101	13
200102	4.5
200106	87
200107	6.5
200108	20
200109	120
200110	36
200112	95
200111	39
200105	2
200103	28
200104	47
200160	10
200161	10



US-54 carries an average two-way ADT of 5,000, with 28 percent trucks. The estimated design 18K ESAL in the SHRP lane is 469 with a total of 4,690,250 18K ESAL applications over the 10-year design period.

There were no known deviations from project guidelines. All test sections were located between the cities of Greensburg and Haviland, Kansas. There are no horizontal curves located in the SHRP areas and the vertical grade in the sections varies from -0.05 to +0.62 percent in the direction of travel. All sections are located on fill sections, and none contain underground structures.

No weather station has been installed to date, but one is scheduled for installation in 1994. A weigh-in-motion system was installed and is operating at station 598+00, and was supplied by a contractor from Saskatoon, Saskatchewan.

Project Coordination

The Kansas DOT conducted the materials sampling and testing, and also provided their own Resident Engineer. Dennis Hermanson served as Construction Engineer and Bob Armstrong, P.E. served as Project Engineer for the DOT. The following people were actively involved in the project:

Kansas Department of Transportation:

Bob Armstrong
Dennis Hermanson
Kansas DOT
P.O. Box 409
Pratt, KS 67124
(316) 672-7494

Paul Gianokon
Jack McClelland
Kansas DOT
500 N. Hendricks
Hutchinson, KS 67501
(913) 663-3361

Bill Parcels
Kansas DOT
2300 Van Buren
Topeka, KS 66611
(913) 296-7410

Lonnie Ingram
Richard Riley
Rodney Maag
Kansas DOT
Docking State Office Bldg.
Topeka, KS 66612
(913) 296-3711

North Central Regional Coordination Office:

Gene Skok
Ann Johnson
Ron Urbach
Braun Intertec
1983 Sloan Place - Suite 10
St. Paul, MN 55117
(612) 776-7522

Richard Ingberg
FHWA
1983 Sloan Place - Suite 10
St. Paul, MN 55117
(612) 776-2210

The general contractor for this project was:

Popejoy Construction Co., Inc.
Box 385
Ulysses, KS 67880
Phone: (316) 356-3404

Venture Corporation was subcontracted to perform all of the work required for the construction of the SPS-1 project, including grading and paving.

Layout

Figure 1 shows the project layout, and Table 3 gives a description of the sections. Three SPS-9 sections were constructed just west of the SPS-1 experiment. Sections were laid out according to base type and surface layer thickness. Three supplemental sections were the first sections in the SPS-1 experiment, followed by the KDOT control section. Six sections containing dense graded aggregate base were next, followed by the six sections containing asphalt treated base. Two supplemental sections, each containing 5-1/2 inches of asphalt surfacing over dense graded aggregate base were placed last.

Material Sampling and Testing

A summary of the Material Sampling and Testing Plan is shown in Figure 4. KDOT personnel conducted all sampling and testing and data collection, with assistance from the LTPP North Central Regional Office. Table 4 gives a listing of all samples taken for the project.

Construction

Construction of the project began in the Fall of 1992, with all required removals and utility relocations. Work on the base and subbase preparation was scheduled to begin May 1, 1993, but was delayed due to rain. Work did begin in late May, but was slow. The contractor experienced several problems during construction, many of which were caused by the weather. The area experienced much higher than average precipitation during the spring of 1993, resulting in delays and a wet subgrade. To dry out the subgrade, the contractor was allowed to incorporate flyash.

During the FWD testing, high deflections were measured in the base in some areas. These deflections will continue to be monitored. Also, when placing the asphalt treated base, the material rolled out beyond the design width. There was also segregation in the mix. Both problems were corrected with adjustments in construction methods.

All work was completed on the test sections, and the roadway opened to traffic on November 1, 1993.

Table 3. Kansas SPS-1 Section Layout

Construction Station	SHRP ID	Base	Surface
239+00 to 244+00	200162	9-1/2" Bit. Base Subbase	1-1/2" ARS
297+00 to 302+00	200163	8" DGAB	4" KDOT Mix
308+00 to 313+00	200164	Subbase	12" KDOT Mix
509+00 to 514+00	200159	Subbase 4-6' Borrow	11" KDOT Mix
515+55 to 520+55	200101	8" DGAB	7" KDOT Mix
531+50 to 536+50	200102	12" DGAB	4" KDOT Mix
538+00 to 543+00	200106	8" ATB 4" DGAB	7" KDOT Mix
554+00 to 559+00	200107	4" PATB 4" DGAB	4" KDOT Mix
560+50 to 565+50	200108	4" PATB 8" DGAB	7" KDOT Mix
569+50 to 574+50	200109	4" PATB 12" DGAB	7" KDOT Mix
576+00 to 581+00	200110	4" ATB 4" PATB	7" KDOT Mix
582+50 to 587+50	200112	12" ATB 4" PATB	4" KDOT Mix
589+00 to 594+00	200111	8" ATB 4" PATB	4" KDOT Mix
611+50 to 616+50	200105	4" ATB 4" DGAB	4" KDOT Mix
622+00 to 627+00	200103	8" ATB	4" KDOT Mix
628+50 to 633+50	200104	12" ATB	7" KDOT Mix
735+00 to 740+00	200160	7" DGAB	5-1/2" KDOT Mix
787+00 to 792+00	200161	11" DGAB	5-1/2" KDOT Mix

Table 4. Bulk Material Sampling During Construction

Material and Sample Description	Number of Samples	Sample Location
Asphalt Concrete Coring - 4" Diam. Cores Bulk Sampling (100 lbs of each mix, uncompacted)	72 5	Regional Contractor Lab Minneapolis, MN
Asphalt Cement 5 gallons each sample	1	Regional Contractor Lab Minneapolis, MN
Materials Shipped to SHRP Asphalt Reference Library		
Asphalt Cement 5 gallon containers	3	SHRP Reference Library Reno, NV
Aggregate 55 gallon drums	5	SHRP Reference Library Reno, NV
Finished Asphaltic Concrete Mix 5 gallon containers	15	SHRP Reference Library Reno, NV

Subgrade Preparation

Because of the heavy rains, the contractor was allowed to incorporate flyash into the subgrade to create a stable working platform. This material was mixed into the upper 7 inches of soil, and is a Type C flyash. The target application rate was 8 percent. According to the Kansas DOT personnel on site, the contractor had problems incorporating the water into the flyash/subgrade mixture. They changed procedures to incorporate the water at the front of the mixing drum. This procedure worked much better. Water was added to increase the moisture content approximately 13.5 percent, although the DOT estimated the target moisture content to be about 17 percent. After the incorporation of the water, a Cat vibratory compactor was used to compact the flyash/subgrade mixture.

In areas where the subgrade is comprised of up to three feet of fill and natural subgrade, two layers were sampled as part of the sampling and testing plan (subbase and subgrade).

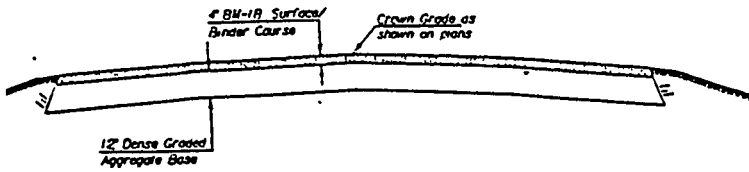
Construction Schedule

Table 5 summarizes the construction schedule for the SPS-1 sections.

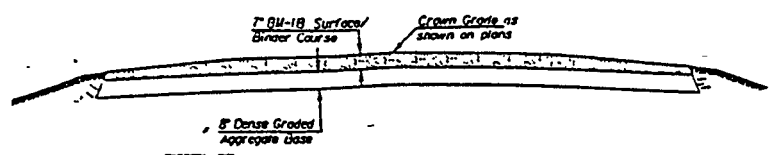
Table 5. Construction Schedule

Test Section		Construction		Range of Thicknesses	MST Completed
Layer	Designation	Start	Complete		
1	Subbase	May 1993	July 1993	0-3'	10/31/93
2	DGAB	May 1993	August 1993	4"-12"	10/31/93
3	PATB	July 1993	Sept 1993	4"	10/31/93
4	ATB	August 1993	Sept 1993	4"-12"	10/31/93
5	Surface	Sept 1993	October 1993	1-1/2"-11"	10/31/93
Dates: Opened to Traffic: November 1993 WIM Installed: October 1993 WIM Operational: October 1993 Weather Station Installed: Not to date Weather Station Operational: No					
Significant Factors Which May Affect Performance of Section					
Environmental Heavy rains delayed construction and resulted in wet subgrade. To dry out the subgrade, the contractor was allowed to incorporate 8% Type C flyash.					
Construction None					

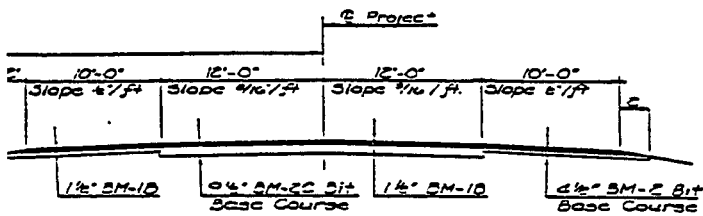
SHRP 2 115.2-115.3 4.5*



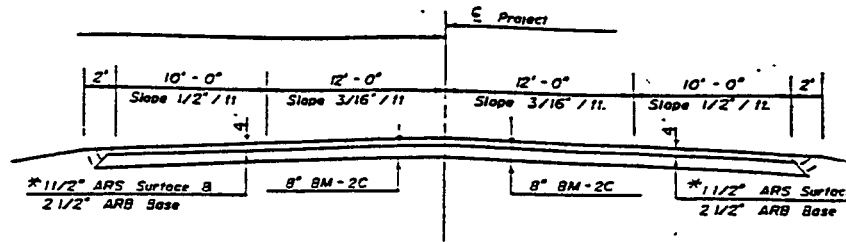
SHRP 1 114.9-115.0 13*



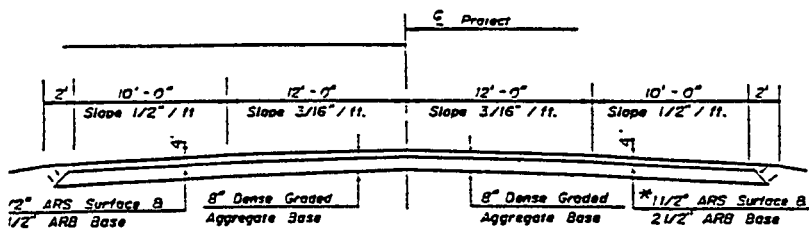
SPS-1 Control 114.8-114.9



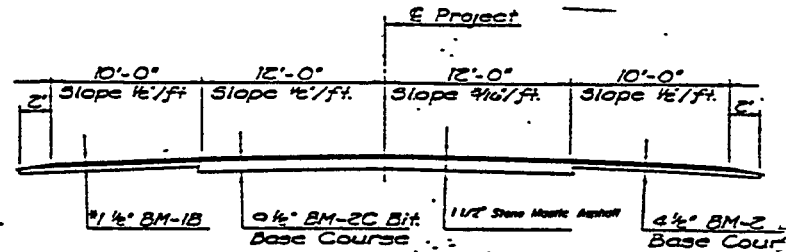
KDOT 6 110.9-111.3 20*



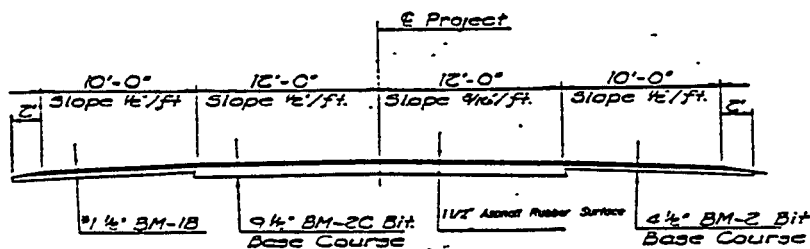
KDOT 5 110.8-110.9 13*



KDOT 4 110.1-110.5 10*



KDOT 3 109.5-110.1 10*



KDOT 2 120.0-120.8 10*

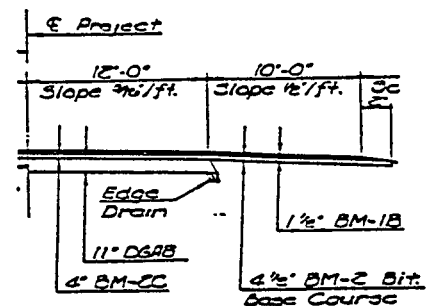
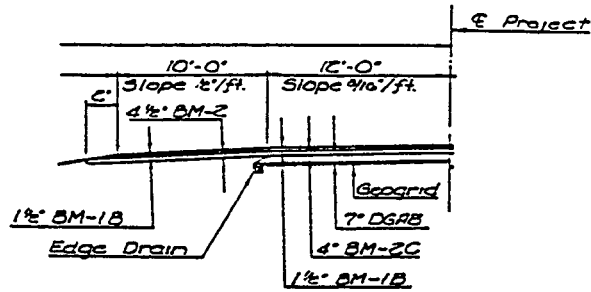
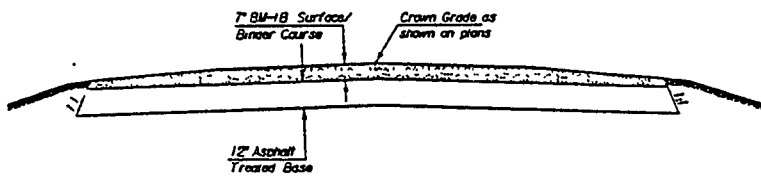


Figure 3. Typical Sections

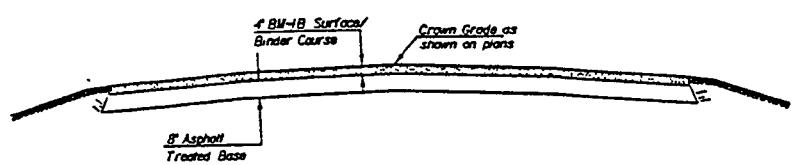
KDOT 1 119.0-120.0 10*



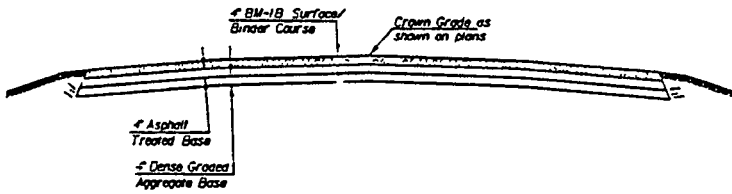
SHRP 12 117.1-117.2 47*



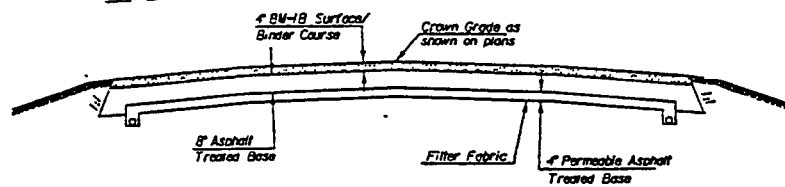
SHRP 11 117.0-117.1 28*



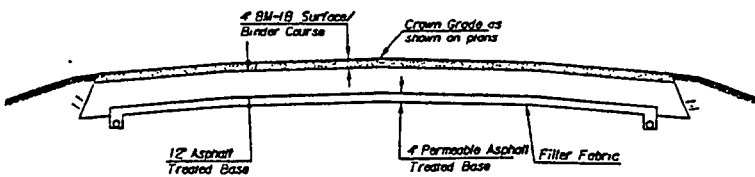
SHRP 10 116.8-116.9 2*



SHRP 9 116.3-116.4 39*



SHRP 8 116.2-116.3 95*



SHRP 7 116.1-116.2 36*

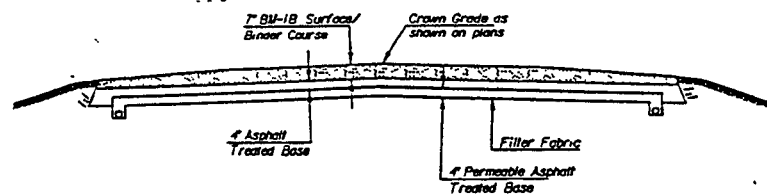
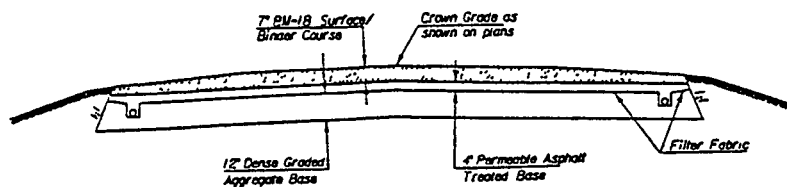
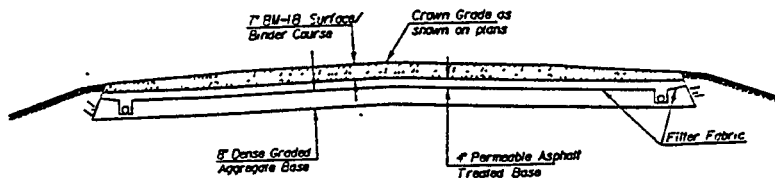


Figure 3. Typical Sections (continued)

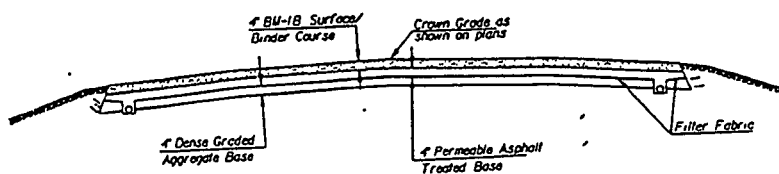
SHRP 6 116.0-116.1 120*



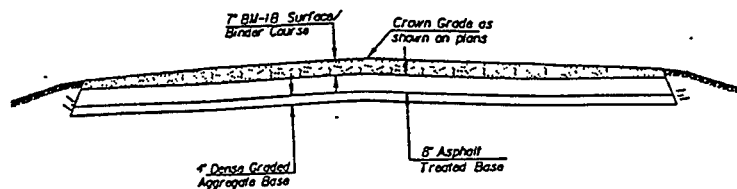
SHRP 5 115.8-115.9 20*



SHRP 4 115.7-115.8 6.5*



SHRP 3 115.3-115.4 87*



* - Design Life of Asphalt

Figure 3. Typical Sections (continued)

Kansas SPS-1 Subgrade Tests

KDOT Standard
200127

200101

200102

200106

200107

200108

200109

A1 A2 A3 O O O T1 T2 T3 + + +		B-1 ■	T4 T5 T6 + + +		A4 A5 A6 O O O T7 T8 T9 + + +		B-2 ■	T10 T11 T12 + + +		A7 A8 A9 O O O T13 T14 T15 + + +		B-3 ■	T16 T17 T18 + + +		A10 A11 A12 O O O T19 T20 T21 + + +		B-4 ■
⊗ S1		⊗ S2		⊗ S3		⊗ S4		⊗ S5		⊗ S6		⊗ S7					

200110

200112

200111

200105

200103

200104

T22 T23 T24 + + +	B-5 ■	A13 A14 A15 O O O T25 T26 T27 + + +	T28 T29 T30 + + +	B-6 ■	A16 A17 A18 O O O T31 T32 T33 + + +	B-7 ■	T34 T35 T36 + + +	A19 A20 A21 O O O T37 T38 T39 + + +	B-8 ■		
⊗ S8		⊗ S9		⊗ S10		⊗ S11		⊗ S12		⊗ S13	

Figure 4. Material Sampling
and Testing Plan

- Bulk Sample Locations (350 Pounds Each) (B1-B8)
- Shelby Tube/Split Spoon Sampling to 4' Below Top of Subgrade (A1-A21)
- + Location of Field Testing (T1-T39)
- ⊗ Shoulder Probe (S1-S13)

Kansas SPS-1 Dense Graded Aggregate Base

KDOT Standard
200127

200101

200102

200106

200107

200108

200109

+ + +
T61 T62 T63

+ + +
T40 T41 T42

+ + +
T43 T44 T45

■ B9

+ + +
T46 T47 T48

+ + +
T49 T50 T51

■ B10

+ + +
T52 T53 T54

+ + +
T55 T56 T57

200110

200112

200111

200105

200103

200104

T59
+ + +
T58 T60

■ B11

Figure 4. Material Sampling and Testing Plan (continued)

+ Location of Field Testing (T40-T63)

■ Bulk Sampling

Also required: 3 Bulk Samples of Aggregate Material
3 Moisture Content Samples at each Bulk Sample Location

Kansas SPS-1 Asphalt Treated Base Tests

200127
KDOT Standard

200101

200102

200106

200107

200108

200109

+ + +
T64 T65 T66

200110

200112

200111

200105

200103

200104

+ + +
T67 T68 T69

Figure 4. Material Sampling and Testing Plan (continued)

+ + +
T70 T71 T72

+ + +
T73 T74 T75

T77
+ + +
T76 T78

T80
+ + +
T79 T81

T83
+ + +
T82 T84

+ Location of Field Testing (T64-T84)

Also required: 3 Bulk Samples of Asphalt Mixture from Plant

Kansas SPS-1 Asphalt Layer Tests

200127 KDOT Standard				200101	200102	200106	200107	200108	200109
C10	+	+	+	C50	C110		C240		C310
C10	+	+	+	C60	C120		C220		C320
C10	+	+	+	C70	C130		C200		C290
C10	+	+	+	C80	C140		C190		C300
C10	+	+	+	C90	C150		C180		C330
C10	+	+	+	C100	C160		C170		C340
C10	+	+	+	C110	C170		C160		C350
C10	+	+	+	C120	C180		C150		C360
C10	+	+	+	C130	C190		C140		C370
C10	+	+	+	C140	C200		C130		C380
C10	+	+	+	C150	C210		C120		C390
C10	+	+	+	C160	C220		C110		C400
C10	+	+	+	C170	C230		C100		C410
C10	+	+	+	C180	C240		C90		C420
C10	+	+	+	C190	C250		C80		C430
C10	+	+	+	C200	C260		C70		C440
C10	+	+	+	C210	C270		C60		C450
C10	+	+	+	C220	C280		C50		C460
C10	+	+	+	C230	C290		C40		C470
C10	+	+	+	C240	C300		C30		C480
C10	+	+	+	C250	C310		C20		C490
C10	+	+	+	C260	C320		C10		C500
C10	+	+	+	C270	C330		C00		C510
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C10	+	+	+	C360	C420		C10		C600
C10	+	+	+	C370	C430		C00		C610
C10	+	+	+	C380	C440		C90		C620
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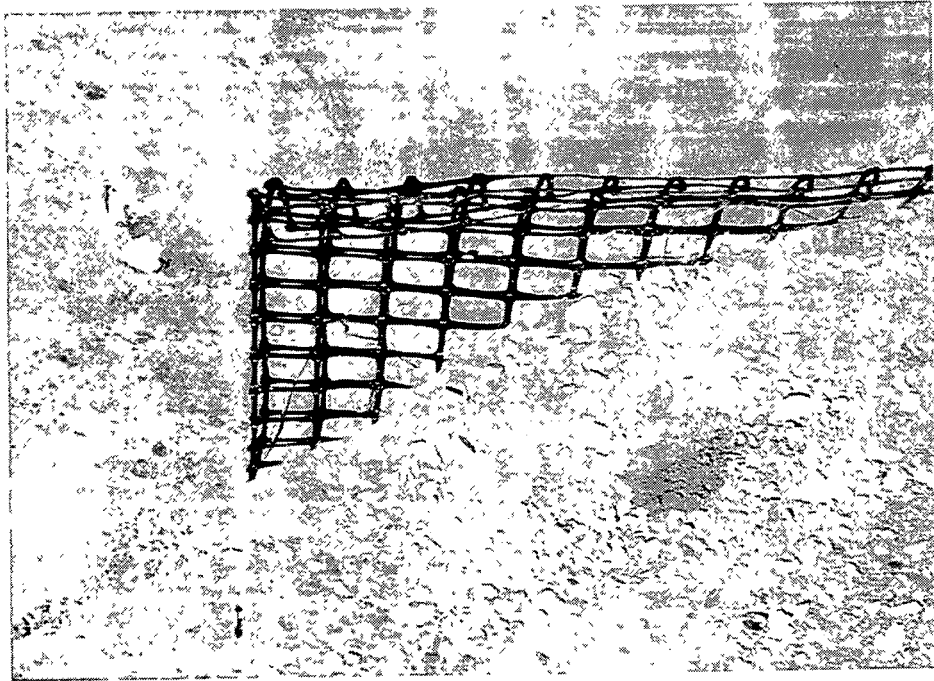
Section 200101
Graded Subgrade



Section 200112
Note Rutting in Subgrade



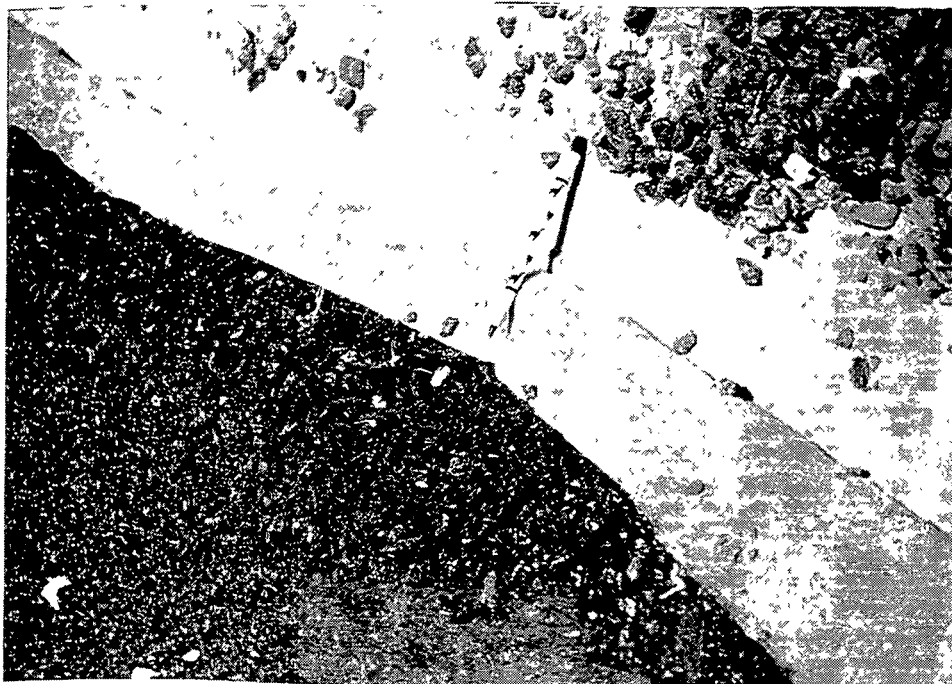
**Dense Graded Aggregate Base
Prior to Placement of Asphalt Layers**



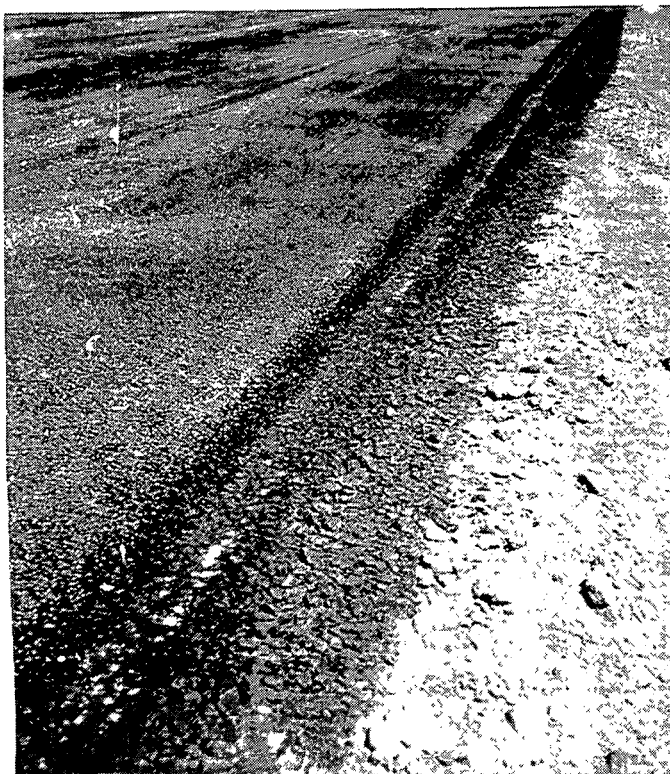
**Section 200160
Geogrid Material Beneath DGAB**



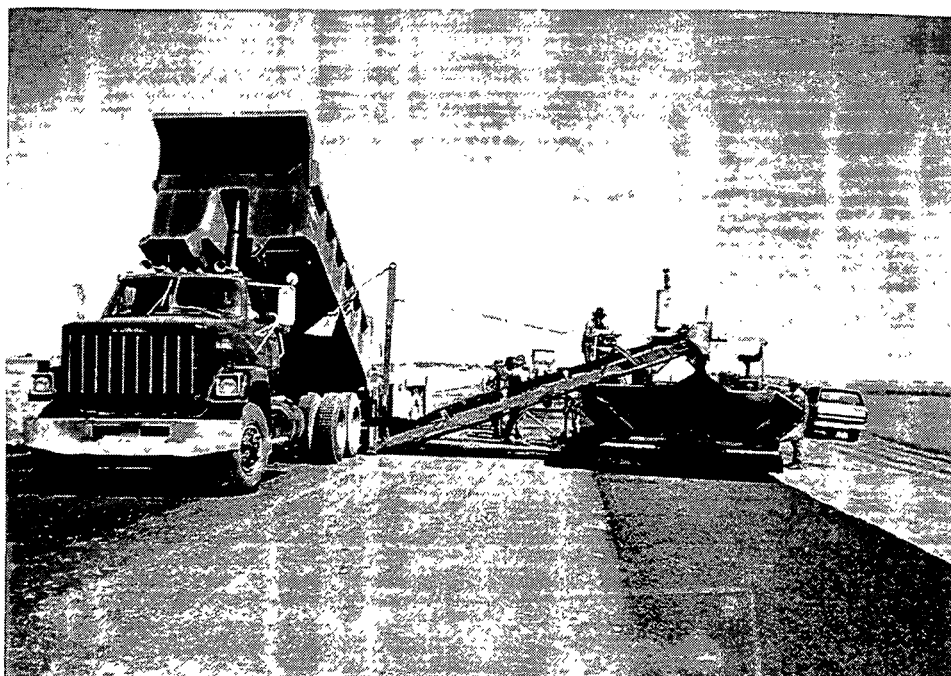
Section 200104
Asphalt Base Course Over Asphalt Treated Base



Section 200107
Filter Fabric Beneath PATB
Note Insufficient Overlap



**Section 200103
Bituminous Base Course Mixture Over
Asphalt Treated Base Over DGAB**



**Section 200107
Paving Shoulder with Side Dump
to Reduce Damage to PATB**



Placement of Filter Fabric in Subgrade Trench